

AI Planning

Exercise Sheet 7

Date: December 12, 2014
 Students: Axel Perschmann, Tarek Saier

Exercise 7.1

(a) $\Pi' = \{V, I, O, \gamma\}$ with

- $V = \{above-a, above-b, above-c, below-a, below-b, below-c\}$
 $\mathcal{D}_{above-\Upsilon} = \{A, B, C, n\} \setminus \{\Upsilon\}$
 $\mathcal{D}_{below-\Upsilon} = \{A, B, C, t\} \setminus \{\Upsilon\}$
 where $\Upsilon \in \{A, B, C\}$
- $I(a) = 1$ for $a \in \{below-b = t, above-b = A, above-a = n, below-c = t, above-c = n\}$
 $I(a) = 0$ else
- $O = \{move-X-Y-Z, move-X-Table-Z, move-X-Y-Table\}$
 $move-X-Y-Z = \langle (below-X = Y) \wedge (above-X = n) \wedge (above-Z = n), (above-Y := n) \wedge (below-X := Z) \rangle$
 $move-X-Table-Z = \langle (below-X = t) \wedge (above-X = n) \wedge (above-Z = n), (below-X := Z) \rangle$
 $move-X-Y-Table = \langle (below-X = Y) \wedge (above-X = n), (above-Y := n) \wedge (below-X := t) \rangle$
 for pair-wise distinct $X, Y, Z \in \{A, B, C\}$
- $\gamma = (above-c = B) \wedge (above-a = C)$

And the addition¹ that every $above|below[:]=\Upsilon$ with $\Upsilon \in \{A, B, C\}$ implies its counterpart (e.g. $above-A[:]=B$ also tests/sets $below-B[:]=A$).

(b) $\Pi'' = \Pi$

The induced propositional planning task Π'' is the (regular) planning task $\Pi'' = \langle A', I', O', \gamma \rangle$, where

- $A' = \{(above-a, B), (above-a, C), (above-a, n), (above-b, A), (above-b, C), (above-b, n), (above-c, A), (above-c, B), (above-c, n), (below-a, B), (below-a, C), (below-a, t), (below-b, A), (below-b, C), (below-b, t), (below-c, A), (below-c, B), (below-c, t)\}$

¹to make this a bit less verbose and better readable

- $I'((v, d)) = \text{iff } I(v) = d$
 $I'((v, d)) = 1$ for $(v, d) \in \{\text{below-}b, n), (\text{above} - b, A), (\text{above} - a, n), (\text{below} - c, t), (\text{above} - c, n)\}$
- $O' = \{\text{move-}X\text{-}Y\text{-}Z, \text{move-}X\text{-}Table\text{-}Z, \text{move-}X\text{-}Y\text{-}Table\}$
 $\text{move-}X\text{-}Y\text{-}Z = \langle (\text{below-}X, Y) \wedge (\text{above-}X, n) \wedge (\text{above-}Z, n),$
 $(\text{above-}Y, n) \wedge \neg(\text{above-}Y, X) \wedge$
 $(\text{below-}X, Z) \wedge \neg(\text{below-}X, Y) \rangle$
 $\text{move-}X\text{-}Table\text{-}Z = \langle (\text{below-}X, t) \wedge (\text{above-}X, n) \wedge (\text{above-}Z, n),$
 $(\text{below-}X, Z) \wedge \neg(\text{below-}X, t) \rangle$
 $\text{move-}X\text{-}Y\text{-}Table = \langle (\text{below-}X, Y) \wedge (\text{above-}X, n),$
 $(\text{above-}Y, n) \wedge \neg(\text{above-}Y, X) \wedge (\text{below-}X, t \wedge \neg(\text{below-}X, Y)) \rangle$
- $\gamma = (\text{above-}c, B) \wedge (\text{above-}a, C)$

(c)

Exercise 7.2

(a) Since both h_1 and h_2 include the blank tile, $h_1 + h_2$ is not admissible.

Proof by counterexample:

$n = 1, m = 2$

	t_0	t_1	t_2	t_3		t_0	—	—	—		—	t_1	t_2	t_3
$s =$	t_4	t_5	t_6	t_7	α_2 -view :	—	—	—	—	α_1 -view :	t_4	t_5	t_6	t_7
	t_8	t_9	t_{10}	t_{11}		—	—	—	—		t_8	t_9	t_{10}	t_{11}
	t_{12}	t_{13}	b	t_{14}		—	—	b	—		t_{12}	t_{13}	b	t_{14}

$$h^*(s) = 1$$

$$h_1(s) + h_2(s) = 1 + 1 = 2$$

$2 > 1$, therefore $h_1 + h_2$ is not admissible.

(b) Basic approach: Goal awareness: for every goal state s_γ of the full puzzle, $h_3(s_\gamma) = 0$ and $h_4(s_\gamma) = 0$. Consistency: since a tile is accounted for in at most one of $\{h_3, h_4\}$, each step necessary to reach the goal counts as either 1 or 0 in $h_3 + h_4$.